Appendix D

Fire and Fuels Specialist Report

Resource: Fuels

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The Little Canyon Mountain (LCM) proposed project area has been visited several times between June and September 2002 in order to understand the existing fire/fuels situation. In addition, extensive stand exams were taken between September 9 and 13, 2002 in order to provide vegetation/fuels input.

Past Management Actions and Historical Conditions Affecting Fire/Fuels in the Project Area

In the past, attempts have been made to exclude fire, primarily through fire suppression. This has had an effect on the distribution and composition of vegetation in the project area. Historical documentation, both written and photographic, indicate that the project area was primarily composed of shrub-steppe vegetation (sagebrush, bunchgrasses, etc.) with occasional ponderosa pine dominated timber stands extending approximately ½ mile from the top of Little Canyon Mountain down into drainages where they established along a moister gradient. Very few, if any, western juniper were present in the project area.

Fire scar analysis documents fire, in the form of low-intensity underburning, as a normal part of the ecosystem in the Blue Mountains for the last 300 years. Although a natural component of forests and grasslands, fire has been excluded for the last 100 years (Hall 1990). In an historic situation for the project area, lightning started a fire that would burn slowly through grass and needles to ponderosa pine trees, and would slowly consume the bark and branches of smaller diameter trees. This slow, hot fire often had three results: "a mineral seedbed [was] provided for pine regeneration, fire carrying grasses and litter [were] eliminated so underburning [was] avoided for two to three fire cycles, and grass competition [was] greatly reduced. During this 20-30 year period, ponderosa pine could grow large enough in diameter to withstand underburning and pinegrass and elk sedge would extend their rhizomes back into the charred area to again carry fire" (Hall 1990). With this type of continuous fire insertion into a ponderosa-dominated ecosystem, only five trees need to become established per acre every 35 years. Without fire, ponderosa stands are not periodically thinned, and thousands of young trees become established. The establishment and growth of ponderosa pines in the understory has also "reduced spatial diversity and created fuel ladders to the taller trees" (Agee 1993). Over time these stands stagnate, and become dense and unhealthy; susceptible to disease and parasite infestations and attack from wildfire.

The purpose of many fuels reduction projects is not to eliminate fire from the ecosystem, but to create fire-resilient forests with characteristics that limit the behavior of surface fires and that have a lower, overall resistance to crown fires. Crown fires are created when a surface fire generates enough heat and energy to combust fuels above the surface, resulting in torching of individual or groups of trees. These characteristics are guided by four principles: reducing fuels on the ground (surface fuels), increasing the distance from the ground to the live crown on the trees, reducing crown density and retaining larger trees (Table 1). Canopy density is quantified by the term "crown bulk density," which is the live foliage weight in pounds per square foot divided by the average live crown length. Crown-bulk density values above 0.006 lbs/ft^3 (where tree crowns touch and overlap) appear to sustain crown-to-crown fire spread, significantly increasing the potential for tree mortality and decreasing the ability of firefighters to safely fight the fire.

Table 1. Principles of fire-resilient forests.

Principle	Method	Effect	Advantage	Concerns
Reduce Surface Fuels	Burning of piles, crushing fuel, prescribed burning.	Reduces potential flame length.	Control of fire is easier, improved safety for firefighters, less torching.	Surface disturbance, less with Rx burning than other techniques.
Increase Height to Live Crown	Thinning smaller trees and pruning up to 10-12 feet, either manually or with Rx fire.	Requires longer flame length before torching can initiate.	Less torching, improved safety for firefighters.	Opens understory, may allow surface wind to increase.
Decrease Crown Density	Thinning in combination with surface fuel reduction	Makes tree-to-tree crown fire less likely.	Reduces crown fire potential, improves firefighter safety.	Surface wind may increase and surface fuels may be drier.
Retain Larger Trees	May be interpreted as a diameter limit when thinning, but includes spacing and should be a recognition that large trees are more fire resistant	Thicker bark and taller trees.	Increases survivability of trees.	Removing smaller trees is economically less profitable.

Adapted from: Fire in Oregon's Forests: Risks, Effects and Treatment Options. Fitzgerald, 2002.

Implementing one or all of these fire-resilient forest principles could reduce the threat or decrease the negative effects of an unplanned wildfire event. On-the-ground evidence demonstrates that reducing or mitigating fuel density and composition can reduce wildfire intensity and the potential for destructive crown fires. Fuel breaks can, and have, caused crown fires to drop to the surface as the fire passed through and was denied the fuel needed to sustain it (Fitzgerald, 2002). Fires restricted to the understory (surface fires) are generally less fatal to trees and other vegetation, and result in less damage to soils and watersheds. On the other hand, stands comprised of mid- and overstory trees, as well as understory vegetation, tend to have a lower crown-base height and an "increased probability that flames of a ground fire will torch the trees" (Fitzgerald, 2002).

Photo from Plot 128, located in the north-central portion of Unit-1. This site demonstrates a dense, small-diameter ponderosa pine stand.

On the lower slopes of LCM, historical documentation points to grassland and sagebrush-steppe communities. Shrub-steppe communities are usually dominated by a variety of shrubs and perennial grasses. "Forest vegetation is generally confined to mountain slopes with sufficient precipitation, either regionally (e.g. approaching the Rocky Mountains) or locally (e.g. higher elevations on interior ranges such as the Blue Mountains)" (Franklin and Dyrness 1988). These communities typically experienced a fire return interval of approximately 25-35 years. Although fire severity may have been moderate to severe, the plants in these ecosystems have adapted. Instead of being eliminated, grassland and mountain shrub communities are generally top-killed and are able to resprout. Fire exclusion and other activities (e.g. grazing) since the area was settled by Europeans has led to an overall decrease in the shrub-steppe ecosystem and the expansion of both ponderosa pine (primarily east/north sides) and western juniper (south/west sides) communities.

With the exclusion of fire, western juniper has greatly expanded in the project area over the last 100 years, occupying much of the southwestern and western slopes of the project area. Western junipers are extremely fire intolerant as seedlings and natural fires have had a strong influence on the distribution of this species. Although they traditionally occupied rocky outcrops and other fire-resistant sites, changes in the frequency of wildfires have allowed juniper to rapidly move into other communities without check. During the "rapid-population growth phase at the turn of the [twentieth century], the western juniper populations on the big sagebrush sites were doubling every 3 years" (Young and Evans 1981). As a result, numerous stands have established in the valleys and foothills of the Blue Mountains, including the LCM project area.

Curlleaf mountain mahogany (*Cercocarpus ledifolius*) is the dominant shrub on much of the project area. This shrub, often found in the mountain brush zone in the Intermountain West is an important browse species for mule deer. Although it may exist as an individual shrub in open forests, it usually occurs in isolated, pure patches that are frequently extremely dense. It is commonly associated with ponderosa pine, Douglas-fir and other fir forests types. This species is important browse because it is one of the few plant species that meets or exceeds the protein requirements for wintering big game animals such as elk or mule deer. Over time, however, excessive browsing, as well as intraspecific competition, leads to an erect growth form that provides little available browse because the animals cannot reach the new growth. Eventually, the stands become dominated by a few over-mature individuals with little or no biomass production and reproduction is minimal (FEIS, Schultz et al., 1990). While suppressed, juvenile plants can grow and survive under a dense overstory for 100 years, they will eventually die if not released from competition with mature mahogany (Schultz et al., 1990).

Curlleaf mountain mahogany reproduces by seed. While mahogany can grow vigorously after pruning, it has a minimal ability to sprout after the plant has been top-killed by fire. However, disturbance such as fire that kills mahogany also opens up mineral soil for seed germination and canopy gaps necessary to release juvenile plants. Seedling survival is compromised by drought, frost and browsing, and for completely unprotected seedlings, survival can drop to 25 percent (FEIS).

Although mahogany may depend on fire to reduce conifer competition and produce favorable soil conditions for reproduction, the shrub itself is highly flammable due to the number of dead branches that persist in mature shrubs, and the heavy, resinous leaves. Moderate to severe fire frequently kills mahogany shrubs, and intense heat, rather than actual contact with flames, is often sufficient to cause mortality (FEIS). For these reasons, young, vigorous stands should not be subjected to prescribed burning, while older, decadent stands may benefit from burning, especially of seedlings are protected by downed branches, fencing or both.

Photo from Plot 37, located in the center portion of Unit-3. This site demonstrates juniper encroachment in a historic shrub-steppe ecosystem, as well as decadent mahogany in the canopy gaps.

In addition to management activities that have altered the vegetation in the project area through fire exclusion, other management activities have had additional impacts in the project area, although to a much smaller degree:

- Roads have been created throughout much of the project area, serving not only as access for recreation and mining, but also as suppression access, as well as public access with the potential of creating accidental or intentional fire starts.
- Historical and current logging operations within the project area, while limited, have removed some of the available timber. This timber has been used historically for the town of Canyon City, and more recently as supports for mining shafts.
- Combined efforts from the BLM and local landowners have created a small fuel break at the Wildland/Urban Interface boundary. The current BLM fuel break project has reduced fuel loads by pre-commercially thinning approximately 70 acres along the northern edge of the project area. In conjunction with these activities, local landowners have taken measures to clean and thin their own properties and create defensible spaces.

Brief Existing/Environmental Conditions

The LCM proposed project area is currently experiencing a build-up of hazardous fuels and a highly probable increase in tree mortality caused by several different bark beetles. These are symptoms of the actual problem, which is a deficit of disturbance in a fire-adapted ecosystem. Lacking fire, the forest has become established in an area shown by historic photos to be a shrub-steppe community with stands of conifers in drainages and on some slopes. The area is now showing the undesired effects of high stand density, which is habitat for bark beetles and conditions ripe for crown fire.

Detailed Existing Environment/Condition – BLM Lands

For the purpose of baseline fire and fuels analysis, the project area was divided into three units, based on vegetative composition and distribution, aspect differences, geographic location, and other site-specific features (See Map XX). Initial baseline stand information was collected for 149 plots within the project area. Unit 1 contains 82 plots, Unit 2 contains 28 plots, and Unit 3 contains 39 plots. For each plot, the following information was determined:

- Number of trees/acre by species and 2 inch diameter class
- Tree height and crown base height for each species and diameter
- Crown bulk density for crown fire potential
- Total tons/acre of foliage and branch material in standing trees
- Basal area/acre for each size and species class
- Dominant surface fuel model, with percent cover and tons/acre by time lag/fuel category.

All fire weather projections used data collected from the Fall Mountain Regional Area Weather Station, #352327, using the 1980 to 2002 weather records. Sample plots were evaluated at the 90th and 97th percentile weather conditions for the 120-day fire season at that station. Table 2 contains the values and conditions for weather at each percentile.

Table 2: Values for 90th and 97th percentile weather conditions.

Variable	90th Percentile Conditions	97th Percentile Conditions
1 hr fuel moisture	3.0 %	2.3 %

10 hr fuel moisture	3.8 %	3.1 %
100 hr fuel moisture	6.1 %	5.1 %
1000 hr fuel moisture	8.4 %	7.5 %
Herbaceous fuel moisture	30 (recorded value is 18, but 30 is minimum for modeling)	30 (recorded value is 6, but 30 is minimum for modeling)
Woody fuel moisture	60 %	56 %
20 ft wind speed	12 mph	14 mph
Temperature	84ºf	88ºf
Relative humidity	17%	13%

In order to calculate expected fire behavior, two modeling programs, Fuels Management Analyst and Nexus, were used. Three plots, representing low, moderate and high total basal areas, were selected from each of the three Units for analysis. Each of these nine plots was modeled at High and Severe weather conditions.[1] From the original input data, rate of spread (chains/hr), flame length (feet), type of fire (surface, conditional, passive crown, active crown) and probability of tree mortality (by size class and species) was calculated (See Table XX – this should reference the No Action red/yellow table).

From these models, crown bulk densities and basal area calculations were also determined. These two factors work in conjunction to provide the basis for fire risk predictions. Basal area alone does not necessarily provide an adequate fuel target because a high basal area, for example, may not indicate severe fire risk if the trees present are evenly spaced, greater than 20 inches dbh and the distance between the ground and the bottom of the crown is 40 feet. At the same time, crown bulk densities may indicate a strong risk of crown fire, however, it is difficult to translate crown bulk reductions into on-the-ground treatment options. These two categories can be used to determine desired number of trees per acre and the overall look of the units.

Unit 1

Unit 1 is the hillside directly adjacent to the homes on the north side of the project area. The hill slopes gently at the base, with slopes ranging between 0 and 35 percent (see Map XX). Vegetation is forested, dominated by ponderosa pine and mixed conifer stands with scattered juniper and a few Douglas-fir dominated sites. Surface fuels cover 100 percent of the ground, and are a blend of models 2, 9 and pockets of model 10 where beetle killed pines are dropping needles and branches, creating fuel jackpots. Ladder fuels, including small trees, low branches of larger trees, and shrubs, are abundant, creating opportunities for surface fires to jump into the crowns in approximately 65 percent of the stands. The canopy closure is frequently 60 to 70 percent, although that varies widely across the slope with some sites being completely closed, and others (particularly western juniper on the western slopes) demonstrating a more savannah-like appearance.

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[1] High weather conditions are considered 90th percentile weather conditions, which includes factors such wind as well as temperatures, relative humidities, and fuel moistures. For the LCM project area, 90th percentile weather means that only 12 days out the 120-day burning period experience equal or higher conditions. At the 97th percentile (severe weather), only 4 days experience equal or higher conditions. Weather information is taken from the Fall Mountain Regional Area Weather Station (RAWS), and data collected from 1980 – 2002 has been averaged to provide high and severe conditions.

At mid-slope in Unit 1, along the mine road, there is a topographic and vegetative change. The overstory changes to Douglas-fir dominance, with pine as a community member rather than the dominant species. More shrubs and ladder fuels are in the understory, the overstory is more dense and closed, and fuel model 10 is more prevalent. The ground transitions from the gentle slopes below to much steeper slopes on the upper mountain, with 40 to 60 percent slopes or steeper describing the terrain.

One interesting note is the lack of large snags, stumps or logs on the site. These remnants of older stands would mean that large, old trees once occupied the site. Their absence, and the relatively young age of the existing trees indicates that prior to settlement the hillside tended toward a grass/shrub ecosystem, maintained by frequent burning.

Unit 2

Unit 2 runs along the east side of the project area and includes Little Pine Creek. This area is comprised primarily of ponderosa pine dominated stands and mixed conifer stands with occasional pockets of western juniper along the northern edge. The riparian area around Little Pine Creek also contains a variety of hardwood species, as well as pine, juniper and Douglas-fir. Toward the top of Little Canyon Mountain there are also few Douglas-fir dominated sites. Mountain mahogany, present as individual shrubs in the mid-range of the unit, becomes more frequent and more clumped toward the top of the mountain as well. This portion of the project area contains the most mining claims and, as a result, the majority of the roads.

Surface fuels in the form of grasses, forbs, shrubs and needle cast, cover 100 percent of the ground. Fuel models are primarily 2 and 9, except where beetle killed pines are dropping needles and branches, creating fuel jackpots (fuel model 10). Ladder fuels, including small trees, low branches of larger trees, and shrubs, are abundant, creating opportunities for surface fires to become active crown fires or exhibit individual torching, in the majority of the stands under 97th percentile conditions.

Slope throughout this unit varies. Along the northern edge, the slope ranges from 0 – 35 percent. At mid-slope, the steepness increases to 70 percent in areas, and then levels out a little more in the upper elevations to 10-40 percent.

Unit 3

Unit 3 runs along the west side of the project area and the majority of the juniper and juniper/ponderosa pine stands. Canyon Creek borders the project area along the western edge of the project area, and Whiskey Gulch runs through this unit as well. Slopes are relatively steep coming up from the highway, ranging up to 76 percent. Surface fuels in the form of grasses, forbs, shrubs and needle cast, cover the majority of the ground, except in some areas along the southern section of this unit where bare soil is exposed between juniper trees. Fuel models are primarily 2 and 9. Ladder fuels, including small trees, low branches of larger trees, and shrubs, are abundant, creating opportunities for surface fires to become active crown fires or exhibit individual torching, in approximately 2/3 of the stands under 97th percentile conditions. Although juniper trees often exhibit a savannah-like appearance, the steep slops and low branches combine to push fire behavior into the crowns.

At the top of Whiskey Gulch, on the western side of Little Canyon Mountain, curlleaf mountain mahogany (CMM) fills a small basin area. For the most part these shrubs are decadent and have very little biomass production, however, these plants have reproduced and small numbers of seedlings are being suppressed by the over-mature overstory. In order to promote the growth of the juvenile plants, these stands dominated by mature mahogany would need to be treated to remove the over-mature individuals and release the young plants. Mahogany on the west slope, however, is not demonstrating any regeneration, very little biomass production, and is too tall and decadent to serve as wildlife forage. Due to the flammable nature of these decadent shrubs, these stands should be thinned and pile burned to reduce the continuous fuel loads on the mountain. Cutting and pile burning may actually serve to scarify the soil sufficiently to stimulate germination from seed sources already stored in the soil.

This unit contains very few roads and fire suppression would be extremely difficult due to the steepness of the slopes and limited access.

Detailed Existing Environment/Conditions – Adjoining Lands

The Malheur National Forest (Strawberry Wilderness Area) abuts the project on the southeast side, and private land borders the rest. In recent history, two fires have burned adjacent to and in portions of the Little Canyon Mountain area. In 1987, the Little Canyon Fire burned approximately 135 acres in the wilderness and along the southeast corner of the BLM land in the project area. This fire burned under severe conditions, and the majority of acres burned under passive and active crown fire behavior. As a result, much of the overstory and understory vegetation was burned completely, and the area, although recovering, is still open. In 1999, the Byram Gulch fire burned up from the Harris Ranch just southwest of the project area, and into the southwest side of Little Canyon Mountain. This fire burned in May and, while it burned intensely, did not initiate a sustained crown fire. A salvage logging operation was conducted after the burn to remove dead and dying trees and to reduce downed fuel loads in the burned area.

In addition to salvage logging, some logging is being conducted on private lands adjacent to the north/northeast side of the project area. In addition, other private landowners, in response to the need to reduce the risk of wildfire to the Canyon City area and their own properties, have been removing the dead and dying beetle-infested trees from their properties, as well as reducing overall fuel loads.

Reasonably Foreseeable Management Actions in the Area not Including the LCM Project
Although not documented, it is reasonable to assume that private landowners would continue to fireproof their own properties adjacent to the project area, and that logging operations would continue, also on private land.

Environmental Effects of No Management Action

The current threat of wildfire to the homes on Little Canyon Mountain and the community of Canyon City is high. Heavy contiguous fuels on the hillside offer no natural breaks or opportunities to slow or stop a fast moving fire under average to severe summer weather conditions. At the same time, the threat of fire starting on private lands and moving upslope onto the public lands is even higher with the public lands above the private. Some work has begun on the private lands adjacent to the boundary to provide a fuel break, but more work is needed on both sides of the property line.

The table below summarizes expected fire behavior under high (90th percentile) and severe (97th percentile) summer weather conditions. As stated above, this chart describes the likelihood that a fire, if it started under these weather and fuel moisture conditions, would turn into either a passive crown fire (individual trees torching) or an active crown fire (sustained fire in the canopy).[1] The 90th and 97th percentile refer to extreme weather conditions that could occur within the 120-day fire season. In other words, 90 percent of the time during the fire season, weather would be less extreme than the 12 days that meet or exceed specified conditions (84° F, 12 mph wind, etc.). In the same fire season, there are only four days that meet or exceed 97th percentile conditions (88° F, 14 mph wind, etc.).

[1] Crown fires are created when a surface fire generates enough heat and energy to combust fuels above the surface, resulting in torching of individual or groups of trees. This causes erratic fire behavior with spotting and major fire runs. Direct attack from fire suppression forces becomes extremely dangerous. Crown fire is the highest intensity category and flame lengths are usually greater than 8 feet and can extend several hundred feet above the canopy. Wind and steep slopes can increase fireline intensity, initiating crown fire earlier (Agee, 1993).

Table 3. Summary of predicted fire behavior under 90th and 97th weather conditions as indicated by the Fall River Regional Area Weather Station.

Representative Stand Fire Behavior Summary Table
Stand Data Generated with FMA Plus, Fire Behavior in NEXUS
No Action Alternative

						90th Percentile Wx				97th Percentile Wx			
Unit	Density	Crown Base Ht	Basal Area	Crown Fuel load (lbs)	Crown Bulk Density (lb/ft)	Critical FL 90	FL 90	ROS 90	Fire Type 90	Critical FL 97	FL 97	ROS 97	Fire Type 97
1	Low	39	62.4	2.03	0.0021	14.8	7.4	15	surface	12.6	8.3	18.4	surface
1	Moderate	19	98.9	3.28	0.0045	9	7.3	40.9	surface	7.7	7.7+	134.5	active cf
1	High	16	163.6	5.11	0.0055	8	7.3	40.9	surface	6.8	6.8+	134.5	active cf
2	Low	22	24.9	0.66	0.0006	10	7.3	40.9	surface	8.5	8.6	54.6	passive cf
2	Moderate	3	100.3	3.23	0.0043	2.5	7.3	40.9	passive cf	2.1	8.5	54.6	passive cf
2	High	40	124.2	3.59	0.0037	15.1	7.3	40.9	surface	12.8	7.3	40.9	surface
3	Low	3	45.7	1.27	0.0026	2.5	1.2	2.2	surface	2.1	1.4	2.8	surface
3	Moderate	14	100.6	4.4	0.0069	7.3	7.3	40.9	surface/passive	6.2	6.2+	134.5	active cf
3	High	2	140.3	5.66	0.0086	1.9	1.9+	68	active cf	1.6	1.6+	134.5	active cf

("+" denotes a critical threshold has been exceeded in the formulas, resulting in an active crown fire.)

Direct Effects on Project Area (1 year, 5 years, and 10 years)

No stand treatments would occur beyond the development of the 70-acre fuel break along the north side of the project area. The increased risk of catastrophic wildfire would continue. Fuels would continue to accumulate over time because the rate of fuel deposition is more rapid than the decay rate in this dry environment. In the event of a wildfire, these "jackpots" of heavy fuels would increase fire behavior and fire intensity.

For the first five years, more fine surface fuels would accumulate as larger trees succumbed to insect infection. This would serve to increase the continuity of surface fuels, feeding fire behavior, and increasing rate of spread and flame length. Branch wood from dead trees would fall and accumulate on the ground, also adding to fire intensity.

Based on predictions from the entomologist, in ten years trees killed by bark beetles would begin to fall, creating openings in which ladder fuel growth would accelerate. These areas would also contain the large branch wood and logs from the fallen trees. The openings would actually serve to add further chances for crown fire initiation because they would add to existing ladder fuel loads and increase energy output (measured by flame length).

Indirect Effects on Resources (1 year, 5 years and 10 years)

As a result of increased tree mortality from beetle infestations, more intense, rapid burning would be expected. This would be caused initially (1-5 years) by the increase in surface fuels (needles, small branches), and subsequently (5-10 years) by the increase in downed woody debris (branch and downed log). As fuels continued to accumulate, the site would create more hazardous conditions for suppression forces by increasing fire behavior and intensity. As a result, the chance that fire behavior would exceed suppression activities would increase over time.

Brief Summary of the Impacts of No Management Action

As a result of the No Action alternative fire risk in the project area would be expected to remain the same or increase over time. Canyon City, already identified as a high-risk town, would continue to be threatened by the potential for stand-replacing wildfire extending into the city limits and outlying residences. Firefighters would be placed at increasing risk as fuel loads, and subsequently fire behavior, increased. The potential for catastrophic impacts to the ecosystem from a large fire would also increase.

Summary Comparison of Alternatives

ALT	**Summary**	**Pre-Treatment Basal Area**	**Post Treatment BA**	**% Fire Type 90th Percentile ***	**% Fire Type 97th Percentile**	**Change in Post-Treat % Fire Type**
A	No Action, 70 ac. fuel break	95.8 ft^2/ac	No change	67% surface 22% active 11 % cond.**	11% surface 11% passive 78% active	No change
B	Thin from below, less than 12 in DBH.	143.0 ft^2/ac (Note: treated area only)	109.2 ft^2/ac	67% surface 17% cond. 16% active	33% surface 33% cond. 34% active	50% surface 33% cond. 17% active
C	Historicial Perspective 30-50/60-100 BA target	100.4 ft^2/ac	30-50 ft^2/ac	44% surface 22% passive 33% active	11%surface 11% cond. 22% passive 56% active	78% surface 11% cond. 11% active
		99.0 ft^2/ac	60-100 ft^2/ac	78% surface 12% passive	44% surface 11% passive 44% active	67% surface 11% cond. 11% passive 11% active
D	Uniform Treatment – 30-50 BA target	95.8 ft^2/ac	30-50 ft^2/ac	67% surface 22% active 11 % cond.	11% surface 11% passive 78% active	89% surface 11% cond.
E	Graded Treatment – 40-50/50-70/ 70-90/90-100 BA target	138.1 ft^2/ac	40-50 ft^2/ac	66% surface 34% passive	66% cond. 34% active	100 % surface
		168.8 ft^2/ac	50-70 ft^2/ac	66% cond. 34% active	100% active	66% surface 34% active
		159.5 ft^2/ac	70-90 ft^2/ac	66% surface 34% cond.	33% surface 33% passive 34% active	66% surface 34% cond.
		119.1 ft^2/ac	90-100 ft^2/ac	100% passive	33% passive 64% active	66% passive 34% active
F	Stratified by Species Treatment – 0-40/40-60/ 60-80/80-100 BA target	81.3 ft^2/ac	0-40 ft^2/ac	66% surface 34% active	66% surface 34% active	100% surface
		178.2 ft^2/ac	40-60 ft^2/ac	33% surface 64% cond.	33% cond. 64% active	66% surface 34% cond.
		164.0 ft^2/ac	60-68 ft^2/ac	66% surface 34% cond.	100% active	66% surface 34% cond.
		145.5 ft^2/ac	80-100 ft^2/ac	66% surface 34% cond.	66% surface 34% cond.	100% surface

* The percent of fire type was calculated from the sample plots selected to represent each alternative. Different representative units were used for each alternative to ensure that the sample plots adequately reflected the pre- and post-treatment conditions anticipated in each action alternative.
** Conditional fire behavior refers to a fire that is on the verge of transitioning between a surface and a passive crown fire.

Environmental Effects of Management Alternatives

<u>Direct Effects on Project Area (1 year, 5 years, and 10 years)</u>

Common to All Action Alternatives

All action alternatives would have an effect on reduction of fire hazard within the units that were treated. This is due to the removal/pile burning of fuels in numerous size classes that would provide a reduction in surface fuels such as needle-cast and small shrubs, and a reduction in ladder fuels that allow a surface fire to climb into the tree crowns. The scale and effectiveness of the treatments would vary according to the prescriptions in each action alternative.

Common to B – D

Alternatives B – D, like the No Action Alternative, would not target dead and dying beetle-infested trees for removal, unless they were removed as part of the thinning from below process. Over time, as these trees died, dead and down fuels would accumulate in the project area, leading to more intense fire behavior in the event that a fire started. This would be caused initially by the increase in surface fuels (needles, small branches), and subsequently by the increase in downed woody debris (branch and downed log). As fuels continued to accumulate, the site would create more hazardous conditions for suppression forces by increasing fire behavior and intensity. As a result, the chance that fire behavior would exceed suppression activities would increase over time.

Alternative B

This alternative would treat and establish a fuel break up to but not exceeding 1000 feet inside the project boundary. Based on restrictions provided in the alternative only 225 acres would be treated, located in the northeast/east sections of the proposed project area. Within these 225 acres, trees would be thinned from below up to 12 inches diameter at breast height (DBH). Due to limitations on treatment in unroaded areas, this alternative would not treat acres nearest Canyon City or the residences that border public lands. As a result, this alternative is not expected to have much of an effect on reducing the threat of an unplanned wildfire event to Canyon City. The Wildland Urban Interface Zone would not be able to be managed for surface fire behavior in this alternative.

The average basal area prior to action in the area available to treat is approximately 143 ft^2/acre. Following treatment, the basal area in the treated area is an average of 109.2 ft^2/ac. Basal areas on all other plots would remain the same as the No Action Alternative.

Predicted fire behavior in the treated stands would change from an average of 34 percent of the area initiating crown fire under 97th percentile conditions to 17 percent of the of 225 acres initiating crown fire under 97th percentile conditions. Fire behavior in the rest of the area would remain the same as the No Action Alternative.

The combination of heavy, contiguous fuels, excessive fuel loads and dense stand conditions would continue to threaten the safety of nearby communities, as well as the safety of fire fighters protecting the area. In the lower elevations on the Canyon City side of the project area, beetle induced mortality would continue to cause fuel accumulations, capable of creating intense fire behavior. Ladder fuels, including small trees, low branches and shrubs would continue to be abundant in the majority of the project area, generating opportunities for surface fires to climb into the crowns. Effective fire suppression would remain a challenge, and firefighter safety would remain a concern due to the potential for extreme fire behavior.

Alternative C

This alternative would treat over 2,000 acres in the proposed project area to two different basal area targets. In the lower slopes, toward Canyon City, basal area targets are 30-50 ft^2/acre. In the upper slopes, where pine and fir stands were historically established, the target basal area would be 60 –100 ft^2/acre. In addition, some areas, containing large numbers of western juniper, would fall well below the low-end basal area targets. Curlleaf mountain mahogany would be targeted on the western slopes to reduce overall fuel accumulations. Mature, decadent mahogany shrubs would be cut and pile-burned to eliminate flammable material. While no specific Wildland Urban Interface Zone would be designated, the low-end basal area target of the historic perspective would effectively create a zone around Canyon City and nearby residences where the fuels would be managed for surface fire (flame lengths less than 4 ft.). Surface fire flame lengths are safely manageable by ground based suppression forces under most conditions.

The average basal area in the lower slopes would change from approximately 100.4 ft^2/acre to 30 – 50 ft^2/acre. In the higher elevations, the basal area would change from an average of 99.0 ft^2/acre to 60-100 ft^2/acre. In some cases, the target basal area would already be met, and little or no treatment would be required.

Predicted fire behavior in the treated stands would change from an average of 78 percent of the lower area initiating passive or crown fire under 97th percentile conditions to only 11 percent of the acres in the project area initiating crown fire under 97th percentile conditions. In the upper elevations (target basal area 60 – 100) predicted fire behavior in treated stands would change from an average of 55 percent initiating passive or active crown fire to only 22 percent of the acres in the project initiating crown fire under 97th percentile conditions. In addition, approximately 210 acres would be retained in pre-treatment condition to 100-150 ft^2/acre to maintain wildlife habitat. These stands, although susceptible themselves to crown fire, would be scattered throughout the project area and the project area would still be managed for surface fire.

Although a few areas remain at risk for crown fire, for the most part, any crown fire advancing on the urban area would be expected to drop to the surface and burn with intensities that are safely and effectively managed by ground based suppression forces.

Alternative D

This alternative would treat over 2,000 acres in the proposed project area to a single, uniform basal area target of 40 – 60 ft^2/acre. While no specific Wildland Urban Interface Zone would be designated, This low-end basal area target would effectively create a zone around Canyon City and nearby residences, and throughout the entire project area where the fuels would be managed for surface fire (flame lengths less than 4 ft.).

The average basal area would change from approximately 98.8 ft^2/acre to 40 – 60 ft^2/acre. Predicted fire behavior in the treated stands would change from an average of 89 percent of the project area initiating passive or crown fire under 97th percentile conditions to only 11 percent of the acres in the project area promoting conditional (transitioning from surface to passive crown fire) under 97th percentile conditions.

Although very few areas remain at risk for individual torching/passive crown fire, for the most part, any fire would be expected to remain on the surface and burn with intensities that are safely and effectively managed by ground based suppression forces.

Alternative E

This alternative would treat almost 2,200 acres in the proposed project area to four different basal area targets. In Level 1, nearest Canyon City, basal area targets would be 40-50 ft^2/acre. In Level 2, the target basal area would be 50 –70 ft^2/acre. In Level 3, the target basal area would be 70 –90 ft^2/acre. And in Level 4, at the top of the mountain, the target basal area would be 90 –100 ft^2/acre. In addition, beetle-infected ponderosa pine trees would be targeted initially to reach basal area reductions. This would ensure reduced amounts of fuel accumulations over time and offer more long-term protection from stand-replacing wildfire. Curlleaf mountain mahogany would be targeted on the top of the mountain to promote regeneration and seedling survival. Mature, decadent mahogany shrubs would be pruned and the branches scattered to protect seedlings from early over-browsing. While no specific Wildland Urban Interface Zone would be designated, the low-end basal area target of Level 1 would create a zone around Canyon City and nearby residences where the fuels would be managed for surface fire (flame lengths less than 4 ft.). Surface fire flame lengths are safely manageable by ground based suppression forces under most conditions.

The average basal area in Level 1 would change from approximately 138.1 ft^2/acre to 40 – 50 ft^2/acre. In Level 2 the average basal area would change from 168.8 ft^2/acre to 50 – 70 ft^2/acre. In Level 3, treatment would change the average basal are from approximately 159.5 ft^2/acre to 70 – 90 ft^2/acre. In the highest level, the basal area would change from an average of 119.1 ft^2/acre to 90-100 ft^2/acre. In some cases, the target basal area would already be met, and little or no treatment would be required.

Predicted fire behavior in the treated stands would change from an average of 34 percent of the lowest level area initiating passive or crown fire under 97th percentile conditions to 100 percent of the acres in the project area maintaining a surface fire under 97th percentile conditions. In Level 2, predicted fire behavior in treated stands would change from an average of 100 percent initiating active crown fire to only 34 percent of the acres in the project initiating crown fire under 97th percentile conditions. In Level 3, predicted fire behavior would decrease from an average of 67 percent initiating passive or active crown fire to only 100 percent of the acres in the project maintaining surface or conditional fire conditions. In the highest level (4), predicted fire behavior in treated stands would not change and would retain an average of 100 percent initiating passive or active crown fire.

Several areas, particularly in the higher elevations remain at risk for passive or active crown fire. Higher basal area targets would not reduce dense stands to the extent necessary to reduce fire intensity. While most of the project area would be managed for surface fire, the top of the mountain remains at risk for stand replacing conditions, and the potential, under extreme weather conditions, remains for a crown fire, to burn with an intensity to great to be safely and effectively managed by ground based suppression forces. In turn, higher intensities increase the risk to Canyon City and nearby residences.

Alternative F

This alternative would treat almost 1900 acres in the proposed project area to four different basal area targets. In the western juniper dominated stands basal area targets are 0 – 40 ft^2/acre. In ponderosa pine dominated stands basal area targets increase to 40-60 ft^2/acre and in mixed conifer stands the basal area target would be 60 – 80 ft^2/acre. In the Douglas-fir dominated stands the target basal area would be 80 – 100 ft^2/acre. Curlleaf mountain mahogany would be targeted on the western slopes to reduce overall fuel accumulations. Mature, decadent mahogany shrubs would be cut and pile-burned to eliminate flammable material. In addition to the designated target basal area reductions, 185 acres would be left untreated at 100 – 150 ft^2/acre as wildlife habitat. While no specific Wildland Urban Interface Zone would be designated, the low-end basal area target of the juniper and ponderosa pine stands, which naturally occur along the outer edges of the project area would effectively create a zone around Canyon City and nearby residences where the fuels would be managed for surface fire (flame lengths less than 4 ft.). Surface fire flame lengths can be safely manageable by ground based suppression forces under most conditions.

The average basal area in the juniper plots would change from approximately 81.3 ft^2/acre to 0 – 40 ft^2/acre. The average basal area in the ponderosa-dominated plots would change from approximately 178.2 ft^2/acre to 40 – 60 ft^2/acre. In the mixed conifer sites the average basal area would change from approximately 164.0 ft^2/acre to 60 – 80 ft^2/acre In the Douglas-fir sites, the basal area would change from an average of 145.5 ft^2/acre to 80-100 ft^2/acre. In some cases, the target basal area would already be met, and little or no treatment would be required.

Predicted fire behavior in the treated stands would change from an average of 34 percent of the juniper stands initiating crown fire under 97th percentile conditions to 100 percent of the acres in the project area maintaining surface fire under 97th percentile conditions. In the ponderosa pine stands predicted fire behavior would change from an average of 64 percent initiating active crown fire to only 34 percent of the acres in the project initiating a conditional passive crown fire under 97th percentile conditions. In the mixed conifer stands predicted fire behavior would change from 100 percent initiating active crown fire to only 34 percent of the acres in the project initiating a conditional passive crown fire under 97th percentile conditions. In the Douglas-fir stands predicted fire behavior would change from an average of 34 percent initiating conditional passive crown fire to 100 percent of the acres in the project maintaining surface fire under 97^{th} percentile conditions. In addition, as stated above, approximately 185 acres would be retained in pre-treatment condition to 100-150 ft^2/acre to maintain wildlife habitat. These stands, although susceptible themselves to crown fire, would be scattered throughout the treatment area and the project site would still be managed for surface fire.

Although a few areas remain at risk for crown fire, for the most part, any crown fire advancing on the urban area would be expected to drop to the surface and burn with intensities that are safely and effectively managed by ground based suppression forces.

<u>Indirect Effects on Resources (1 year, 5 years and 10 years)</u>

Common to All Action Alternatives

Proposed treatments may lessen the risk – to varying degrees – of a catastrophic fire event occurring in the project area and running into the community of Canyon City and nearby residences. Thinning trees reduces overall canopy cover and opens up the stands, reducing the risk of crown fire, however, thinning also allows for faster growth of young trees, which will result in crowded conditions if stand densities are not maintained into the future with additional mechanical or prescribed burn entries.

Possible Design Criteria or Mitigation Measures that could be used to reduce impacts to resource

None identified.

Glossary of Terms

Crown Bulk Density: the mass per unit volume of combustible crown biomass, including foliage, twigs, and branches.

Canopy density: Canopy density is quantified by the term “crown bulk density,” which is the live foliage weight in pounds per square foot divided by the average live crown length.

Crown base height: Height of the bottom of the live crown from the ground surface. This varies not only by species, but also by the age and height of individual trees. When young, ponderosa pine trees’ branches are close to the ground. As they age, the lowest level of branches gets farther away from the ground, effectively increasing the crown base height.

Crown Fuel load: Similar to crown bulk density in that it is a measure of volume, however crown fuel loads take spatial arrangement and other factors into account. Fuel load is the amount of live or dead vegetation – or available fuel – in the crown of trees. This is a combination of the fuel arrangement (how the fuel is organized vertically or horizontally), fuel moisture (amount of moisture in live or dead fuel which effects the amount of heat required to cause ignition), and the fuel size (from small needles to large branches).

Flame Length: The length of flames in a fire front measured along the slant of the flame, from the midpoint midpoint of its base to its tip. Flame length is related, mathematically, to tree crown scorch height and fireline intensity.

Critical Flame Length: The flame length at which the fire intensity moves from a ground fire to a crown fire.

Rate of Spread: The rate at which a fire spreads, measured in distance per unit of time (e.g. chains/hour, meters/second).

Basal Area: The cross-sectional area of a tree stem (usually at breast height) or of a range plant stem (usually at ground level). Stand basal area is often described as the total basal area per given unit area (ft^2/acre).

Crown Fire: Crown fires are created when a surface fire generates enough heat and energy to combust fuels above the surface, resulting in torching of individual or groups of trees. These characteristics are guided by four principles: reducing fuels on the ground (surface fuels), increasing the distance from the ground to the live crown on the trees, reducing crown density and retaining larger trees (Table XX). Crown-bulk density values above 0.006 lbs/ft^3 (where tree crowns touch and overlap) appear to sustain crown-to-crown fire spread, significantly increasing the potential for tree mortality and decreasing the ability of firefighters to safely fight the fire.

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